

SUMMARY

Plant Genebanking Training Workshop

April 24-26, 2018

Background

In May 2017, the National Plant Germplasm Coordinating Committee (NPGCC) discussed a concern that an estimated 30% of the staff members of the USDA National Plant Germplasm System (NPGS) would be eligible to retire during the next five years. At present, there is no overall strategy for training their replacements. In response to this concern, a proposal titled “Planning Conference to Develop Strategies for Training the Next Generation of U.S. Plant Genebank Managers” was submitted to USDA-NIFA in July 2017 by Dr. Pat Byrne (Colorado State University) and Dr. Gayle Volk (USDA-ARS). The proposal was funded and resulted in the convening of a Plant Genebank Training Workshop April 24-26, 2018 to discuss how to train the next generation of plant genetic resource managers, researchers, students, and users. The Workshop website is <http://genebanktraining.colostate.edu/index.html>.

2017 NIFA Conference Proposal Objectives

- 1) Host a conference to identify the pedagogical options, logistics, and curriculum topics for a U.S. plant genetic resource management training effort, with major emphasis on a distance-learning course
- 2) Design a strategy to develop, deliver, and sustain a plant genetic resource management training program

Workshop Approach

A total of 33 experts representing USDA-ARS, USDA-NIFA, land-grant universities, seed industry, Mexico’s and Canada’s genebanks, a botanic garden, and an international non-governmental organization (NGO) for plant genetic resource conservation convened at the USDA-ARS National Laboratory for Genetic Resources Preservation in Fort Collins, CO April 24-26, 2018 to discuss the needs, pedagogical approaches, delivery platforms, educational content, and mechanisms for sustaining a possible future plant genetic resources management training program (Appendix 3, Workshop Attendees). Attendees provided 10-15 minute summary presentations for NPGS operations and key subject areas, accessibility/utility to customers, international perspectives, distance-learning, and business models for program sustainability. Each presenter provided some background on existing training opportunities, topics that could be included within their subject area, as well as possible timeframes/platforms for delivery (Appendix 1, Presentation summaries; Appendix 2, Workshop Agenda). Attendees then separated into two breakout groups: 1) NPGS genebank and information management, 2) Ensuring utility of germplasm and associated information. Each breakout group was charged with identifying possible delivery platforms and content. The workshop concluded following a discussion of the results of the workshop deliberations, and general considerations of subsequent, follow-up steps and activities.

Outcomes

The workshop participants acknowledged and recognized that:

- 1) training opportunities could target many different audiences including, but not limited to, the general public, university students, current and future genebank managers, curators and technical staff, the private sector, NGOs, other federal agencies, and the international genebank community. Each audience would have different backgrounds and experiences and would have different reasons/needs for training in plant genetic resources.
- 2) training programs and materials were available for certain aspects of plant genetic resources management in the U.S. and internationally. The participants recommended that information about these existing training opportunities be made widely available.
- 3) additional training resources were needed specifically relating to genebanking concepts (i.e. why certain operations are conducted, not just how); NPGS operations; plant genetic resource regulations; and the applications to plant genebanking of key subject areas such as phenotyping, genotyping, envirotyping, and germplasm utilization.
- 4) scientific expertise is available within the NPGS and other communities, and that knowledge and expertise should be “captured” before personnel retire.
- 5) course content, presentation, and evaluation are all key components of successful training opportunities. Both long-term information resource “libraries” as well as instructor-led training opportunities are needed.
- 6) course content must be updated regularly to reflect scientific and technological advances.
- 7) up-front costs will be incurred for content development and long-term costs will be incurred to ensure the sustainability of training opportunities, particularly if there is personalized instruction.
- 8) more than technical training is needed; other key topics may include communication, leadership, management practices, etc.
- 9) the plant science (and wider) community must be informed about the resources that have been developed.
- 10) mentoring and on-the-job training will play an important role in the training process.

Proposed training program

The overall goals of the proposed training program are:

- 1) To build and sustain the human capacity to appreciate, maintain and promote utilization of plant genetic resources.
- 2) To educate professionals in principles and practices of genetic resources management, utilization, and conservation.

The proposed training program could include the following elements (Figure 1):

- 1) A Resource Library, publicly available at one or more sites, providing “learning objects” and documents. The “learning objects” are 1-15 minute content presentations (images, video, text, links to other resources) that can be stand-alone or incorporated into other education content free of charge. The documents may include best practices, SOPs, regulations, handbooks, popular press articles, links to other resources, etc. Content in the Resource Library would be

reviewed for accuracy before posting. The Resource Library may be hosted by GRIN-Global or other shared platforms.

- 2) A website platform whereby existing training opportunities (within the US and abroad) and their course content are communicated or delivered.
- 3) A distance learning resource likely hosted by a consortium of universities and sustained through tuition or fees.
- 4) An online course, webinar, and/or in-person workshop component which periodically provides specific content (that could include phenotyping, genotyping, envirotyping, big data, regulations, seed testing, etc).

Rationale

Element 1: The development of publicly available Resource Libraries by content-matter experts will capture key expertise and enable flexibility for content use and application by providing material as “learning objects”. The documentation of content makes key information and resources publicly available at all times, so users can access it when the need arises. Posted materials can be updated as needed. Resource library materials could also be incorporated into existing courses.

Element 2: Information about existing training opportunities will be made publicly available on a website.

Element 3: The distance learning opportunity provides personalized training in a continuing education or university academic program, either with or without credit/transcripts. This coursework would be created, in part, by education training experts. Distance learning opportunities reach a wide audience and can still provide personalized instruction. Offering distance learning through a multi-institution platform such as AgIDEA may reduce development costs and reach wider audiences, increasing program cost-effectiveness.

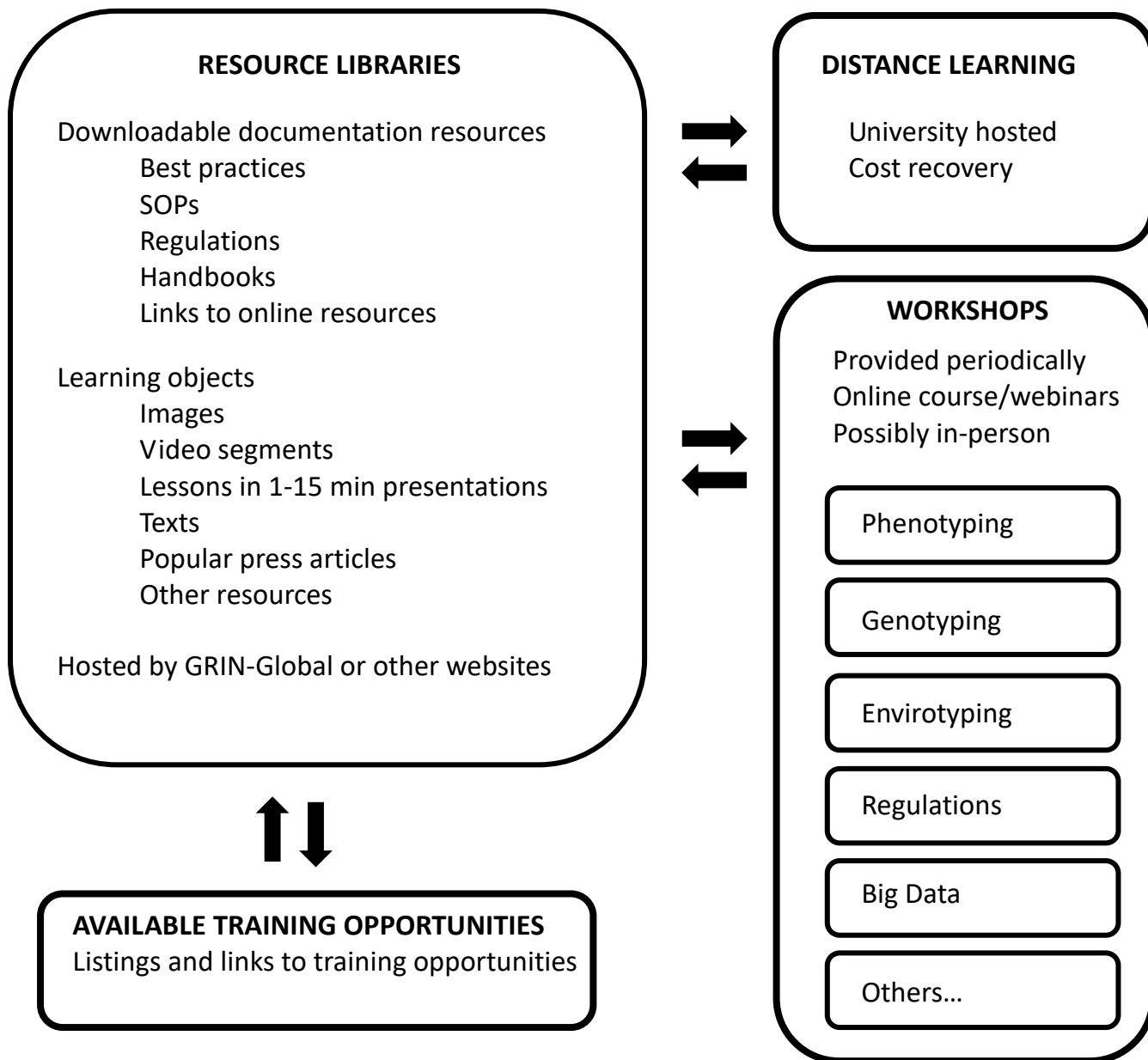
Element 4: Subject-specific workshops provide opportunities for interested individuals to acquire in-depth knowledge in areas where the technology may be actively changing or where hands-on practice and experiences are needed.

Next steps:

Summary information from the Plant Genebank Training Workshop will be shared with the NPGS community and as presentations at meetings of the Plant Germplasm Operations Committee, American Society for Horticultural Science, Crop Science Society of America, National Association of Plant Breeders, American Seed Trade Association, and other interested organizations. Feedback from these groups will be incorporated into the design of the training program.

A Higher Education Challenge (HEC) Grant proposal will be submitted to USDA-NIFA to explore multi-institutional training program options and support the initial development of a Resource Library (website design, compilation of available documentation, creation of sample learning objects). Given the goals of the HEC program, this proposal will focus on development of materials for academic curricula. Additional opportunities will be explored to fund other elements of the envisioned training program.

Figure 1. Diagram of the relationships among training program elements.



Appendix 1. Brief summaries of selected presentations

OVERARCHING TOPICS AND PRESENTERS

Distance Learning, Deena Namuth-Covert and Debora Colbert

Courses should be designed with the end in mind. Have clear, measurable learning objectives, concise strategies to meet learning objectives, and clear expectations of course assessment strategies. Plan for multiple methods of presentation, multiple means of student action and expression, and multiple modes of student engagement. “Bloom’s taxonomy” provides a conceptual framework to assess desired levels of learning, including remembering, understanding, applying, analyzing, evaluating, and creating. When learning, students can be engaged with the instructor, with the content, and with other students. Design course content in terms of “learning objects”, smaller stand-alone pieces of content, to enable repackaging, multi-use, translations, and updating. Use and build-on existing content. Consider ADA accessibility. Choose a platform that is flexible and meets needs. Make sure materials are accessible and well-publicized. Include evaluation experts as courses are developed.

International perspectives, Luigi Guarino

Current training opportunities at an international level: Bioversity, University of the Philippines Los Banos (MSc); UPM Spain; U. Saskatchewan, Canada; UNALM, Mexico; CGN, The Netherlands; Bioversity; Genebank Platform (CGKB), Millennium Seed Bank, Kew; FAO; International Treaty; Int. Society for Biological and Environmental Repositories. FAO has documented that “Despite these efforts, however, human resource capacity is still far from adequate at virtually all levels and in all disciplines related to plant genetic resources conservation and use. In many countries, gene bank staff are too few and are inadequately training to collect, classify, conserve, regenerate, characterize, document and distribute PGRFA.” (<http://www.fao.org/docrep/015/i2624e/i2624e00.htm>). Bottlenecks in the plant genetic resources human capacity include policy, genotyping, markets for landraces, participatory breeding, conservation planning, data management, PPP in plant breeding, conservation techniques (<https://doi.org/10.1007/s10681-017-1935-z>). Consider the following: don’t be too specialized; include use and impact; plan for differences in audiences, length, and levels; build around quality management; factor in mentorship; remember other languages.

Public Outreach, Pablo Jourdan

Communication skills are critical for genebank managers so they know how to best interact with the public, media, and others. The NPGS would benefit from improved, higher quality outreach.

Business Models, Wayne Smith

Texas A&M has a Distance Plant Breeding Program that enables students to advance their training and education in their current location (not necessarily on a Texas A&M campus). Students have access to the same courses, homework, and examinations as those that are on campus, but use online technologies to acquire MS and PhD degrees. Costs vary with in-state and out-of-state status. Cost ranges from \$6000-12,000/year for each student to participate. Texas A&M also offers continuing education programs in plant breeding that are self-paced and self-assessed and do not result in a degree (no university enrollment). A genebank management program could be an academic degree, continuing education certificate, and could be managed by various entities. 1 full time professor (full time teaching

9 credits/semester = 27 credits per year costs \$100K). Students pay \$566 per credit in state and 900 per credit out of state.

NIFA Opportunities, Joyce Parker

NIFA offers Research, Education, and Extension programs through capacity building and competitive grant funding opportunities. Education programs are targeted at many audiences including minorities, K-12, 2 year colleges, 4 year colleges, Masters, doctoral, and post-docs. The Higher Education Challenge Grant Programs 1) Address a state, regional, national, or international educational need; 2) Involve a creative or non-traditional approach toward addressing that need that can serve as a model to others; 3) Encourage and facilitate better working relationships in the university science and education community, as well as between universities and the private sector, to enhance program quality and supplement available resources; and 4) Result in benefits that will likely transcend the project duration and USDA support.

Accessible and Useful to Customers, Margaret Smith and Dave Bubeck

Users expect high quality genebank materials that are well documented, characterized and evaluated. Curators should be trained in all aspects of genebank management including acquisition, conservation, evaluation/characterization, documentation, and distribution. There will always be more ideas and demand for germplasm and information than resources allow. Ensure a strategic approach to prioritize across species in the midst of changing global needs. Consider opportunities that will create enthusiasm driving a future supply of graduate students and undergraduates to choose NPGS employment. The USDA-ARS should provide a global model for plant genetic resource management, established and maintained via NPGS, with critical examples of the value and long-term importance of germplasm.

GENEBANKING

Genebanking basics/NPGS structure/NLGRP, Gayle Volk and Christina Walters

Individual topics for genebanking basics could include: Genebanks are scientific collections; Quality management principles; Genetic resources on a scale of biodiversity (ecosystem/community/species/population/individual/etc); Plant germplasm biology. Genebank infrastructure would include topics such as different types of genebanks (CG centers, national genebanks, NPGS). Discussion topics associated with the National Laboratory for Genetic Resources Preservation, which provides safety duplication of sites and research to increase genebanking efficiency, include preservation basics, propagules and preservation technologies; and challenges to efficient preservation.

Genebanks for seed-propagated genetic resources, Candice Gardner

Key functions of the sites: Acquisition, Distribution, Documentation, Maintenance, Characterization/Evaluation, Utilization. Expertise needed at most sites includes: crop curation, maintenance, distribution/technology transfer, database management and use, pathology, stakeholder interactions, research and breeding, facilities support. Provided a list of genebanking-related courses available through U.S. universities.

Genebanks for clonally-propagated plant genetic resources, Kim Hummer

Management of seed/clonal genetic resources have similar objectives as those focused on seeds: collect, maintain, distribute, evaluate, document. Conservation of genes (species diversity) and genotypes (clones). Additional key topics: propagation techniques, collection maintenance (protected environment vs field collections; containers, irrigation, nutrition/pest management, secondary back-up security; pathogen testing and elimination); genotyping; phenotyping.

Information management, Gary Kinard and Candice Gardner

GRIN-Global is an international plant genetic resource information management system that offers training modules. GRIN-Global documents critical control points, best management procedures, information capture, and annotation at each step of germplasm processing and maintenance.

Intellectual Property and Genetically Engineered Traits, Stephanie Greene

Intellectual Property Protection: Key topics are: Global overview; What's protected; National Perspective. These are important in genebanking because NPGS germplasm is in the public domain. Acquisition, documentation, maintenance, and distribution of IPR are affected, in part because Plant Variety Protection and Journal of Plant Registrations voucher materials are in the NPGS. Genetically Engineered Traits: Overview of the subject; its impact on genebanking, particularly with respect to acquisition, documentation, maintenance, regeneration, and distribution. Include the role of testing for genetically-engineered traits in incoming and regenerated germplasm.

Import/Export Regulations, Gary Kinard

NPGS materials are imported and exported within the US and internationally. Regulations and phytosanitary issues significantly affect these processes. Key references include "Plants for Planting Manual"—which is the encyclopedia for importing germplasm to the US. (https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/plants_for_planting.pdf) The "Export Program Manual" is the encyclopedia for exporting plants and plant products. (https://www.aphis.usda.gov/import_export/plants/manuals/domestic/downloads/xpm.pdf). APHIS system supports for export include Phytosanitary Certificate Issuance and Tracking (PCIT) and the Phytosanitary Export Database (PExD). Plant explorations are covered in some international training courses. In many cases, import/export/exploration expertise is best gained through interactions with NPGS experts.

Committee Involvement, Sarada Krishnan and Bill Tracy Many different committees support the US National Genetic Resources Program and the US National Plant Germplasm System, including 1) National Genetic Resources Advisory Council (NGRAC); 2) National Plant Germplasm Coordinating Committee (NPGCC); 3) Regional Technical Advisory Committees (RATCs); 4) Crop Germplasm Committees (CGCs); 5) Plant Breeding Coordinating Committee (PBCC). Curators must know how to present their programs professionally and clearly to these committees. Curators must also recognize the advocacy role that committees play and clearly outline needs and deficiencies without being negative. The Crop Germplasm Committees create Crop Vulnerability Statements and "quad" charts so that others can understand the vulnerabilities and threats, NPGS PGR status and impacts, Genetic research and breeding capacities, and priority issues for each NPGS crop.

ADDITIONAL KEY SUBJECTS

Phenotyping, Michael Gore

Numerous training phenotyping workshops are available. Key topics are: Germplasm acquisition and selection; Experimental design; Data collection and processing.

Genotyping and Genomics, Chris Richards

Genomics is valuable for genebanks to assess, maintain, and increase collection and accession identity (defining similarity, finding duplication, defining metrics), integrity (temporal variation; drift effects vs selection), diversity (defining genetic lineages and relationships, estimating genetic structure, estimating history), and access and utility (defining subsets, designing priority accessions for genotyping, developing populations for genotyping; anticipating haplotype mining projects, data management and interoperability).

Collection coverage and crop wild relatives, Colin Khoury

Experiential learning applied to crop wild relatives makes the topic interesting. Topics such as plant explorations, in situ conservation, gap analyses for crop wild relatives and landraces; trait-based gap analyses, and spatial analysis are important. There are many opportunities to learn spatial analyses, but application of that approach to genebanking is rare.

Appendix 2. Workshop Agenda

Topic	Presenter/moderator (10-15 min)
4/23/2018, Monday	
3:00 Optional Seminar, "NIFA Issues and Budgets" Lory Student Center Room 290 Grey Rock Room, Colorado State University	Parag Chitnis, Deputy Director of the National Institute of Food Production and Sustainability,
4:30 Optional NLGRP tour, meet in NLGRP lobby	
4/24/2018, Tuesday	
7:55 "Housekeeping" items	P. Byrne, G. Volk, K. Jewell
8:00 Welcome and Introductions	D. Harmel, J. Leach, P. Chitnis
8:45 The need for a plant genetic resources training program	P. Bretting, G. Volk, P. Byrne
9:15 Training program topics for Genebanking basics/NPGS structure/NLGRP/standards	G. Volk, C. Walters
10:00 Break	
10:15 Training program topics for Seed-based sites including regeneration, viability, and distribution	C. Gardner
11:15 Training program topics for Clonal sites (field maintenance, duplication/security back-up, etc)	K. Hummer
12:00 Working lunch and presentation of NPGS and its value to research/breeding	J. Leach
1:00 Training program topics for ensuring germplasm is accessible and useful to customers	M. Smith, D. Bubeck
2:00 International perspective on training program topics and needs	L. Guarino
2:30 Distance-learning concepts and logistics	D. Colbert, D. Namuth-Covert
3:00 Break	
3:15 Summary of key items and brainstorming for training program ideas	P. Byrne
3:30 Potential business models for long-term sustained support of a training program	W. Smith, E. Kaleikau, J. Parker
4:30 Adjourn	
7:00 Dinner (depart hotel at 6:30 to walk) Coopersmiths	
4/25/2018, Wednesday	
8:00 Training program topics for germplasm phenotyping	M. Gore
8:45 Training program topics for germplasm genotyping and genomics	C. Richards
9:30 Training program topics for germplasm information management	G. Kinard, C. Gardner

10:00	Break	
10:15	Training program topics for collection coverage including crop wild relatives and in situ conservation	C. Khoury
11:00	Training program topics for IP and PGR with GE traits	S. Greene
11:30	Training program topics for International/national regulations/logistics for explorations, import, export, phytosanitary	G. Kinard
12:00	Training program topics for committee involvement (CGCs, RTACs, NGRAC etc)	S. Krishnan, W. Tracy
12:30	Working lunch and presentation	P. Gepts
1:30	Summary of key items and brainstorming for training program ideas, including necessary academic training	G. Volk
2:00	Breakout sessions	
1)	NPGS genebank and information management, including seeds and clonal	C. Coyne
2)	Ensuring utility of germplasm and associated information; Germplasm phenotyping/genotyping/genomics	M. Gore
3)	Training program topics for International/national regulations/logistics for explorations, import, export, phytosanitary/in situ conservation/committees/IP/GMO	G. Kinard
3:30	Break	
4:00	Presentation of program outlines for breakout groups 1, 2, and 3 (30 min each)	
5:30	Adjourn	
7:00	Dinner (depart hotel at 6:45 to walk) Restaurant 415	

4/26/2018, Thursday

8:00	Public outreach and education	P. Jourdan
8:30	Summary and discussion of breakout sessions	G. Volk
9:15	Continued discussion and recommendations for potential business models for sustained support	W. Smith
9:45	Perspectives from Kansas State	M. Draper
10:00	Break	P. Jourdan
10:30	Next steps: Outreach, Higher Education Challenge Grant	G. Volk and P. Byrne
11:15	Concluding remarks	E. Kaleikau, P. Bretting
11:30	Box lunch	
1:00	Optional NLGRP tour	

Appendix 3. Plant Genebank Training Workshop attendees.

Attendees	Institution
Bubeck, David	DuPont Pioneer, Johnston IA
Byrne, Pat	Colorado State Univ.
Cianzio, Silvia	Iowa State Univ.
Colbert, Debora	Colorado State Univ.
Coyne, Clare	USDA-ARS, Pullman WA
	Centro Nacional de Recursos
de la Torre, Fernando	Geneticos, Mexico
Diedrichsen, Axel	Genetic Resources Canada
Draper, Marty (by phone)	Kansas State Univ.
Gardner, Candy	USDA-ARS, Ames IA
Gepts, Paul	UC Davis
Gore, Mike	Cornell Univ.
Greene, Stephanie	USDA-ARS Fort Collins CO
Guarino, Luigi	Crop Trust, Bonn, Germany
Hummer, Kim	USDA-ARS Corvallis OR
Jourdan, Pablo	Ohio State Univ.
Khoury, Colin	USDA-ARS Fort Collins CO
Kinard, Gary	USDA-ARS Beltsville MD
Krishnan, Sarada	Denver Botanic Gardens
Leach, Jan	Colorado State Univ.
Misra, Manjit (by phone)	Iowa State Univ.
Namuth-Covert, Deana (by phone)	Ohio State Univ.
Richards, Chris	USDA-ARS Fort Collins CO
Smith, Margaret	Cornell Univ.
Smith, Wayne	Texas A&M Univ.
Tracy, Bill	Univ. of Wisconsin
Volk, Gayle	USDA-ARS, Fort Collins CO
Walters, Christina	USDA-ARS Fort Collins CO
Zhong, Gan-Yuan (by phone)	USDA-ARS Geneva, NY
Resource	
Bretting, Peter	USDA-ARS, Beltsville MD
Chitnis, Parag	USDA-NIFA Washington, D.C.
Harmel, Daren	USDA-ARS Fort Collins CO
Kaleikau, Ed	USDA-NIFA Washington, D.C.
Parker, Joyce	USDA-NIFA Washington, D.C.
Logistical Support	
Henk, Adam	USDA-ARS Fort Collins CO
Jewell, Kierra	Colorado State Univ.